Active Battery Management System with Physics Based Life Modeling Topology, Phase I

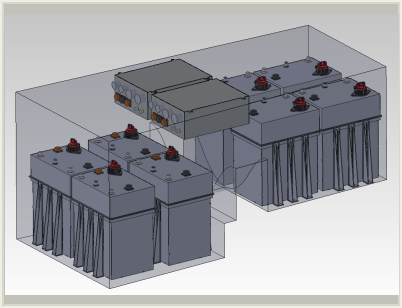
Completed Technology Project (2017 - 2017)

Project Introduction

Robust Data Acquisition on flight applications enables Researchers to rapidly advance technology. Distributed Electric Propulsion (DEP) and Hybrid Electric architectures rely heavily on batteries to achieve fuel efficiency and reduced CO2 emissions. DEP Aircraft of the future have demands for Energy Storage Systems with large counts of cells put in series and parallel to achieve needed voltage and energy levels. The X57 Maxwell Battery comprises of over 6000 cells. As the pack goes through repeated charge/discharge cycles, as well as environmental cycles, each individual cell begins to lose its capacity. Cell to cell capacity variation causes the entire pack to limited by the weakest cell. Traditional Passive Balancing topologies are limited in their ability to address cell mismatch on the discharge cycle. Active balancing allows a dynamic measurement & control system to discharge cells at variable rates. With a more robust measurement & control architecture, Active topologies have the ability to integrate more advanced algorithms. These algorithms include predictive health monitoring, life based management, physics based cell modelling. Batteries can last longer, avoid thermal runaway, and avoid maintenance. EPS is proposing development of an active BMS concept, with associated algorithms to achieve a 40% life improvement on the X57 pack.

Anticipated Benefits

This project is targeted for NASA's X-planes with lithium based energy storage systems. The X57 Maxwell is the target application, however, other X-planes, as well as Space applications may re-use the research to extend pack life, and avoid unpredicted Thermal Events. Vertical Take off & Lift working groups studying air taxi transportation.All commercial aviation applications with a lithium ion battery have the ability to benefit from this research. No deployed Li-Ion battery system in Aviation today has an active topology. This is due to the stringent FAA DO311 requirements which require designers to show that their systems can meet a 1E-9 probability requirement of failed condition occurring such as overcharge. This is achieved through redundancy and the elimination of single point failures. With charge current being transferred from cell to cell, no one has achieved a cost effective design that meets the 1e-9 requirement. If the TRL is advanced on such a topology, the economics of lithium becomes much more compelling given the much improved cycle life. Other key markets who could benefit from Research would be the Air Taxi Manufacturers. Much of their business model is based on the economic properties of the battery. Right now cell manufacturers who are achieving the energy density targets for the application are no where near the cycle life requirement to make this market viable. This technology fills a critical gap in both cycle life and certification aspects.



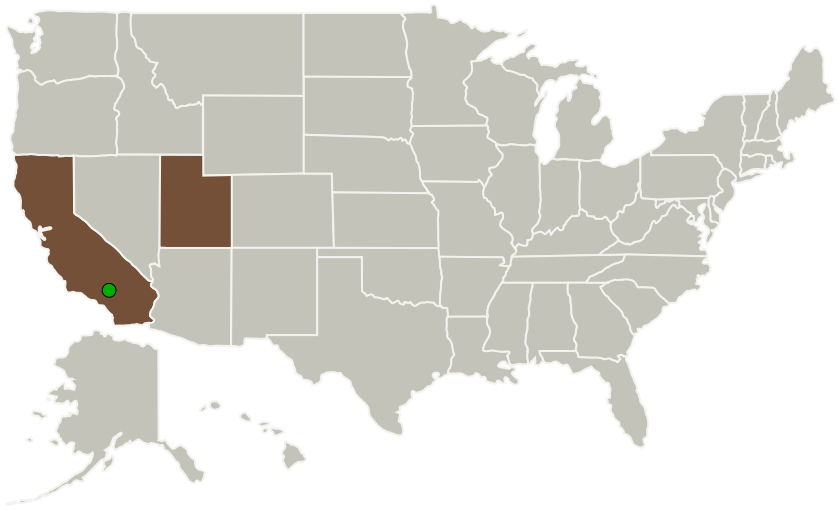
Active Battery Management System with Physics Based life modeling topology, Phase I Briefing Chart Image

Table of Contents

Active Battery Management System with Physics Based Life Modeling Topology, Phase I

Completed Technology Project (2017 - 2017)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Electric Power Systems	Lead Organization	Industry Small Disadvantaged Business (SDB)	Chandler, Arizona
Armstrong Flight Research Center(AFRC)	Supporting Organization	NASA Center	Edwards, California

Primary U.S. Work Locations	
California	Utah

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Electric Power Systems

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Kurt J Kloesel
Bruce R Cogan

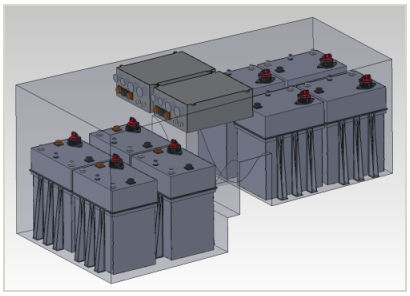
Principal Investigator:

Randy Dunn

Active Battery Management System with Physics Based Life Modeling Topology, Phase I

Completed Technology Project (2017 - 2017)

Images



Briefing Chart Image
Active Battery Management System with Physics Based life modeling topology, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/126672)

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**